11 × 6 = 66   12 × 6 = 72

64 32 16 8 4 2 1
1 1 0 0 1 0 1

Question 1 [15 mark]

A 10
B 11
C 12
D 13
E 14
F 15

a- Perform the following conversions:

2

$(1000111)_2 = (\ 155\ )_6$

$(71)_{10} =$

71 | 6 → 5; 11 | 6 → 5; 1 | 6 → 1; 0

2

$(FAC9.4)_{16} = (\ 175311.20\ )_8$

$((1111\ 1010\ 1100\ 1001 .\ 0100)_4 = (\ 175311.20\ )_2$

1 7 5 3 1 1 . 2 0

64 × 2 = 128

2

$(1100101)_2 = (\ 0001\ 0000\ 0001\ )_{BCD}$

$(101)_{10} \Rightarrow (\quad)_{BCD}$

64 + 32 = 96, + 4 = 100 => 101

128 + 64 = 192

2

8 4 2 1

$(1001\ 0101\ )_{BCD} = (\ 1100\ 0111\ )_{6\text{-}3\text{-}1\text{-}1}$

9 5
1100 0111

128 64 32 16 8 4 2 1
1 1 0 0 1 0 0 1

0

$(11001001)_{Excess\text{-}3} = (\ \ 198\ \ )_{10}$

128 + 64 = 192, + 8 = 100 + 1 = 101

1.5

b- Perform the following operations in binary:

101111/101

$$
\begin{array}{r}
1001.0101 \\
101 \overline{)101111} \\
101 \\
\hline
000111 \\
-\ 101 \\
\hline
01000 \\
101 \\
\hline
00110 \\
-\ 101 \\
\hline
001 \\
\vdots
\end{array}
$$

$\Rightarrow (1001.0101\ldots)$

8 4 2 1

c- Convert and add the following numbers in Binary Coded Decimal BCD.
$(83)_{10}+(77)_{10}$

```
  1
+ 83             1 1 1
  77     1000    0011
-----  + 0111    0111
+160   -------------------
         1111    1010
         0110    0110 +        = 160
       -------------------
        10110    0000   =>  | 1 0110  000 |
```

2

d - Perform the following operation in 2's complement representation and indicate the overflow if occurred. Word length is equal to 6.

32 16 8 4 2 1

-32 + 20

```
 -32               -32                20
 20 +           100000            010100
-----           011111
 -12                 1+
                ------
                100000

                              5     5
                            -2 , +2  -1
                            -32 , +31
```

1.5

```
 100000
 010100 +
--------
 110100
```

out of range

Rong resut

there is No overflow BCS the length = 6

X

Question [2]: [10 mark]

a- Use Demorgan's law then simplify the following function (Use Boolean Algebra).

$$F = \overline{(x+\overline{y})(\overline{x}+\overline{z}\overline{w})(\overline{y}+\overline{z}\overline{w})}$$

$F = \overline{(x+\bar{y})} + \overline{(\bar{x}+\bar{z}\bar{w})} + \overline{(\bar{y}+\bar{z}\bar{w})}$

$= \bar{x}y + x(z+w) + y.(z+w)$

$\bar{x}y + xz + xw + \cancel{yz} + yw$

c.th

$= \bar{x}y + xz + xw + y\cancel{w}$

$\boxed{= \bar{x}y + xz + xw}$ ✓ 6

$x.0=0$
$x.1=x$
$x+\bar{x}=1$
$x.\bar{x}=0$
$x+1=1$
$x+0=x$

$x+\bar{x}y = x+y$

$x \oplus w = \bar{x}w + x\bar{w}$

b- Use Boolean Algebra to simplify the following function.

$$F = x + \bar{x}(x \oplus w)$$

$F = x + \bar{x}\,(x \oplus w)$

$= x + (x \oplus w)$

$= x + \bar{x}w + x\bar{w}$ ✓

$= x(1+\cancel{\bar{w}}) + \bar{x}w$

$= x + \bar{x}w$

$\boxed{= x + w}$

1

9

Question [3]: [10 mark]

A circuit has four binary inputs(a,b,c,d) and three binary outputs (x,y,z,). The fuction of this circuit is to give the number of zeros or ones in its inputs according the following:

If a= 0 the outputs $(xyz)_2$ represent the number of zeros in the four inputs. (a,b,c,d)
If a =1 the outputs $(xyz)_2$ represent the number of ones in the four inputs (a,b,c,d)

We assume that the combinations abcd =0111 and abcd=1000 will never occur. ← dont care

1- Give the truth table ✓
2- Write x as minterm expansion
3- Write y as maxterm expansion
4- Write $\bar{z}$ as maxterm expansion

	8421 abcd	421 xyz	$\bar{z}$
0	0000	1 0 0	1
1	0001	0 1 1	0
2	0010	0 1 1	0
3	0011	0 1 0	1
4	0100	0 1 1	0
5	0101	0 1 0	1
6	0110	0 1 0	1
7	0111	X	X
8	1000	X	X
9	1001	0 1 0	1
10	1010	0 1 0	1
11	1011	0 1 1	0
12	1100	0 1 0	1
13	1101	0 1 1	0
14	1110	0 1 1	0
15	1111	1 0 0	1

$x_{(a,b,c,d)} = \sum m_i (0,15) + \sum d_i (7,8)$

$y_{(a,b,c,d)} = \prod M_i (0,15) \cdot \prod D_i (7,8)$

$\bar{z}_{(a,b,c,d)} = \prod M_i (1,2,4,11,13,14) \cdot \prod D_i (7,8)$ ✓

10

NOR = AND → POS → 0

NAND = OR → SOP → 1

Question [4]: [15 mark]

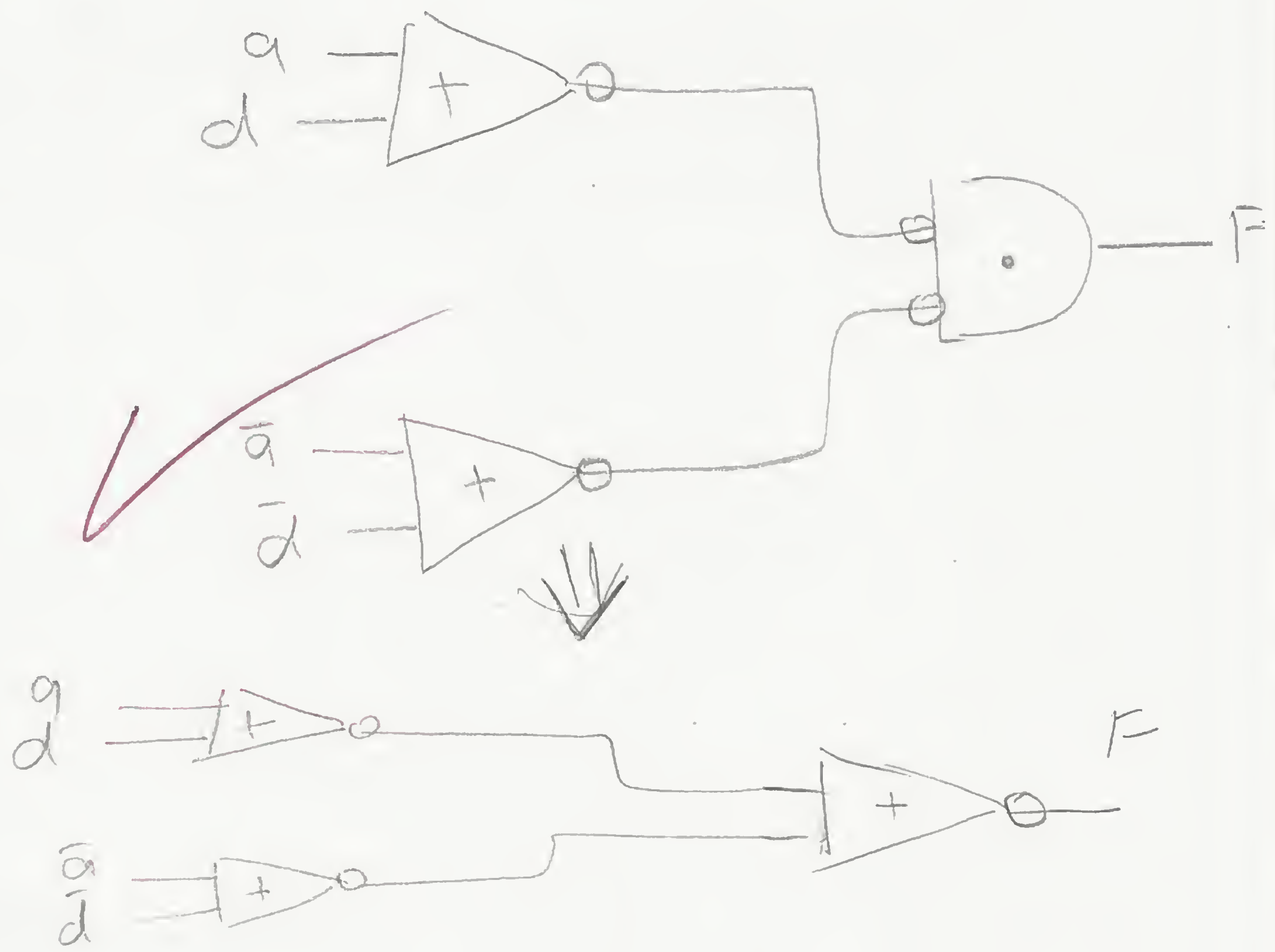
a- Simplify F then implement it as 2 levels NOR-NOR

$F(a,b,c,d)= \sum m(3,5,8,12) + \sum d(1,7,9,10,14)$

cd \ ab	00	01	11	10
00	0	0	1	1
01	X	1	0	X
11	1	X	0	0
10	0	0	X	X

$F = (a+d)\cdot(\bar{a}+\bar{d})$

7



b- Simplify F then implement it as 3 levels OR-AND-OR

$F(a,b,c,d)= \pi M(1,9,11,13,14,15)\ \pi D(5,8)$

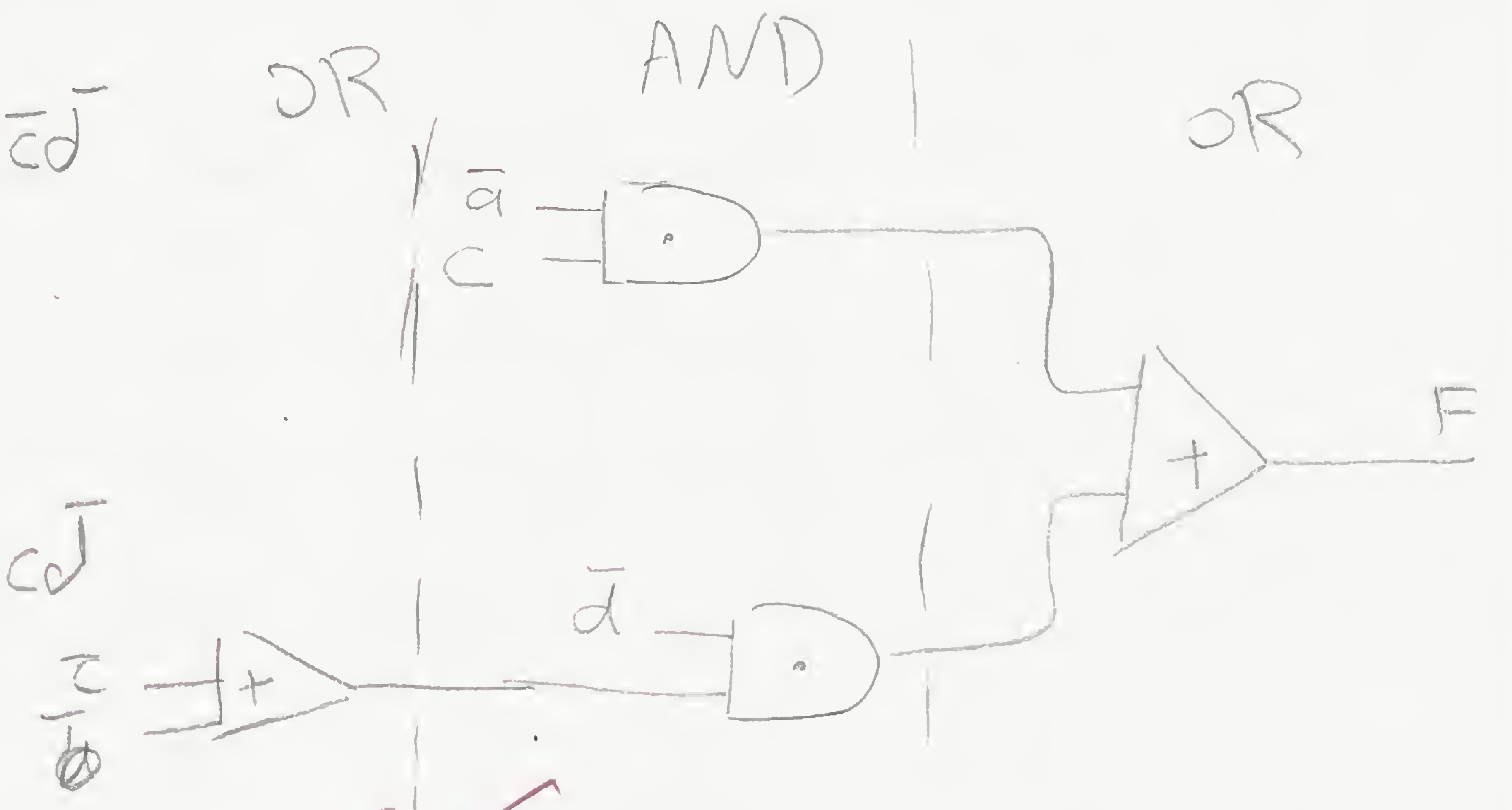
cd \ ab	00	01	11	10
00	1	1	1	X
01	0	X	0	0
11	1	1	0	0
10	1	1	0	1

→ $\bar{c}\bar{d}$

→ $\bar{b}c\bar{d}$

$\bar{a}c$

F=



6(5

$F = \bar{a}c + \bar{b}c\bar{d} + \bar{c}\bar{d}$

$= \bar{d}(\bar{b}c + \bar{c}) + \bar{a}c$

$= \bar{d}(\bar{c} + \bar{b}) + \bar{a}c$